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ABSTRACT

The psychological effects of exercise training are difficult to study in humans, but analogous emotionality changes in animals can be studied using simple measurements employed in emergence and open-field tests. The basis of these tests is that animals that are more emotional are more fearful when placed in a novel situation and will exhibit less exploratory activity. Conversely, less emotional animals will explore a new situation more readily. The emotionality of the following five groups of rats were tested after an eight-week training period: (a) controls or sedentary; (b) runners or treadmill trained; (c) walkers with treadmill exposure; (d) swimmers; and (e) waders. The control rats were judged to be more emotional as indicated by their longer emergence times in the tunnel test; and their longer latency times, greater number of boluses, and lower total squares in the open-field test. Evidence that chronic physical exertion is able to lower emotionality is shown by the greater number of total squares entered in the open-field by the runners and swimmers as compared to other groups. Animal studies such as these may prove useful for studying changes with exercise, just as they have proven useful in psychological research. (Author/JS)

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APPLICATIONS OF ANIMAL RESEARCH IN THE BEHAVIORAL SCIENCES

EFFECTS OF CHRONIC EXERCISE ON EMOTIONALITY IN RATS

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INTRODUCTION

One of the benefits of physical exercise that we hear much about is its ability to produce relaxation, reduce tension and give us a sense of "well-being". This association of physical fitness with mental health has been around a long time and implies that chronic physical exertion can produce beneficial psychological and emotional changes which help us adapt more readily to emotional stresses we may encounter. In support of this concept some human studies have shown a positive correlation between athletic ability and social adjustment (5,6). It has also been demonstrated that tension and anxiety in psychiatric patients can be reduced when they engage in a fitness training program (8). However, these studies may also be telling us that socially well adjusted individuals tend to engage in sports or that the social aspects of group activity provide psychological benefits, especially if a person is depressed beforehand.

This is a difficult question to study in humans because of the many genetic, environmental and social variations operating in the human population. The use of animals to study this problem appeared attractive because one can control their genetic, environmental and social background and thereby examine more precisely the effect of chronic physical exertion on emotionality. Fortunately, psychologists have been investigating psychological changes in animals for many years, so that the literature in this area is extensive and the experimental techniques are well established. One of their principle findings is that handling of any kind, especially in early life, will lower the emotionality of rats in later life.(1,3,7,9).
In the psychological literature the term "emotionality" denotes an "upset or excited condition of the animal" (4). In general, animals that are highly emotional are more fearful or timid when placed in a novel situation and hence will exhibit less exploratory activity. Animals with low emotionality are less fearful and better able to adjust to a new situation, as shown by their greater exploratory behavior in a novel environment.

TECHNIQUES FOR MEASURING EMOTIONALITY IN ANIMALS

Over the years, two very simple tests have been used extensively by psychologists to measure emotionality.

1. Tunnel Emergence Test

In this test the animal is placed in one end of a tunnel and allowed to emerge at the other end. This emergence time indicates his ability to adjust to a novel environment----a short emergence time signifies a less emotional animal (he explores readily when placed in a new situation) and a long time indicates a more emotional animal (he is fearful or cannot adjust to the novel stress). Animals which fail to emerge in one hour are usually assigned a time of 3600 seconds.

2. Open Field Test

This has become the standard technique for testing animal emotionality. It consists of a large open box whose floor is divided into 25 squares by white lines (see Fig. 1). The animal is placed in a corner square and allowed to explore the open field for 5 minutes, during which time various emotionality measurements are

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recorded such as latency, total squares, central squares, defecation and urination. An animal is considered to be more emotional if he has high scores for latency, defecation or urination and low scores for total and central squares entered.

EXPERIMENTAL PROCEDURES

The hypothesis tested in this study was that rats subjected to physical exercise training would be less emotional when confronted with the stress of a novel environment. In other words-----chronic exercise would lower the animal's emotionality.

Male albino rats (150-170 gms) were randomly assigned to five experimental groups: Controls, Runners, Walkers, Swimmers and Waders. Control rats remained in their home cages and were handled only during the weekly weighing. Runners were exercised on a motorized rodent treadmill 5 days per week for 8 weeks. The speed and duration of running was progressively increased until the fourth week, after which they ran at 1 mph for 1 hour, 5 days per week. The Walker rats were walked (0.1 mph for 10 min) 5 days per week for 8 weeks so as to expose them to the psychological aspects of the treadmill and handling routines. Swimmers were forced to swim, in groups of 12-16, in a 55 gallon aquarium in 16 inches of water (32°C) with an overload of 2% of their body weight clipped to their back. As the rats grew, additional weights were added every two weeks and the duration of swimming progressively increased to one hour per day during each two week period. The Swimmers, like the Runners, were trained 5 days per week for 8 weeks. The Wader group of rats was placed in the aquarium for 10 minutes daily for 8 weeks using a water level of only 4½ inches; this provided comparable handling and exposure to water as was experienced by the Swimmers. At the end of the training period all animals were tested for their emotionality level using the Tunnel emergence test and the Open Field test. All parameters were analyzed using a one way analysis of variance followed by orthogonal comparisons of interest.

RESULTS AND DISCUSSION

1. Tunnel Test: The controls and swimmers had significantly longer emergence times than did the other experimental groups. This indicates that these rats are more emotional than the other groups. The lower emotionality of the Runners, Walkers and Waders must have resulted from their handling, rather than from physical exertion, since the emergence times of the Runners and Walkers were not significantly different. The tunnel test does not appear to be a good emotionality test for this strain of rat however, since many rats (29 out of 166) failed to emerge in one hour and were given a maximum time of 3600 seconds. This produced many tie scores which weakened the ability of the tunnel test to detect differences in emotionality.

2. Open Field Test: No significant differences between groups were found in the number of urinations or central squares entered. The control rats had significantly more boluses (defecation) and longer latency times than the other groups---which indicates the controls were a more emotional group. The lower emotionality of the Runners, Walkers, Swimmers and Waders must be a result of the additional stimuli and handling these animals received when exposed to the treadmill and aquarium environments.

The defecation, urination and central squares measurements are judged to be poorer indexes of emotionality in this strain of rat because of their low level of occurrence (defecation, 0.9-1.8; urination, 0.3-0.5; central squares, 0.37-1.78). Low scores such as these severely weaken their power to separate differences in emotionality between groups.

3

The total number of squares entered in the open field has traditionally been the most popular measurement for detection of emotionality in animals. In this study the Runners and Swimmers entered significantly more total squares (55.1 and 52.5) than did the Controls, Walkers or Waders (37.6, 42.2 and 37.8 squares respectively). This indicates that the Runners and Swimmers are less emotional. Since exercise training is the only variable unique to the Runners and Swimmers, this measurement supports the hypothesis that chronic exercise does function to lower emotionality in the rat.

There is an obvious discrepency in these results in regards to the emotionality of the swim trained rats. Their long emergence times indicate a high emotionality while their high nimber of total squares indicates a low level of emotionality. One explanation for this discrepency between the two measurements is that they may be measuring different facets of the animal's emotional make-up, much like Cattell's 16-Personality Factor test measures various facets of a human subjects total personality make-up (2). Accordingly, the results of this study would suggest that either chronic running or swimming will lower the emotionality factor measured by total squares in the open field test whereas only the treadmill running will lower the emotionality factor measured by emergence time in the tunnel test. It should be noted that forced swimming can be stressful to rats because it presents a life and death situation which is not faced by the treadmill trained rats. This added psychological stress may have produced emotionality changes which counteracted the effects of exercise training on this emotionality factor, so that the emergence times remained long.

CONCLUSIONS

From the results of this study it is concluded that chronic physical exertion does provide some cross-adaptation to the stress of a novel environment----that is, exercise can lower some facets of the rat's emotionality. Other facets of emotionality are unaltered by exercise training but can be changed simply by daily handling or exposure to a novel environment. Thus, animal studies may be useful for studying behavioral changes with exercise, just as they have proven their usefulness in psychological research. The simplicity of the emotionality testing equipment and procedures used in these studies lends itself well for future use by other laboratories investigating the effects of chronic exercise training in animals. When working with emotionality changes in animals however, one must be critically aware of the emotionality differences between strains and the great influence that handling of any type has on altering the emotionality of the animals in later life.

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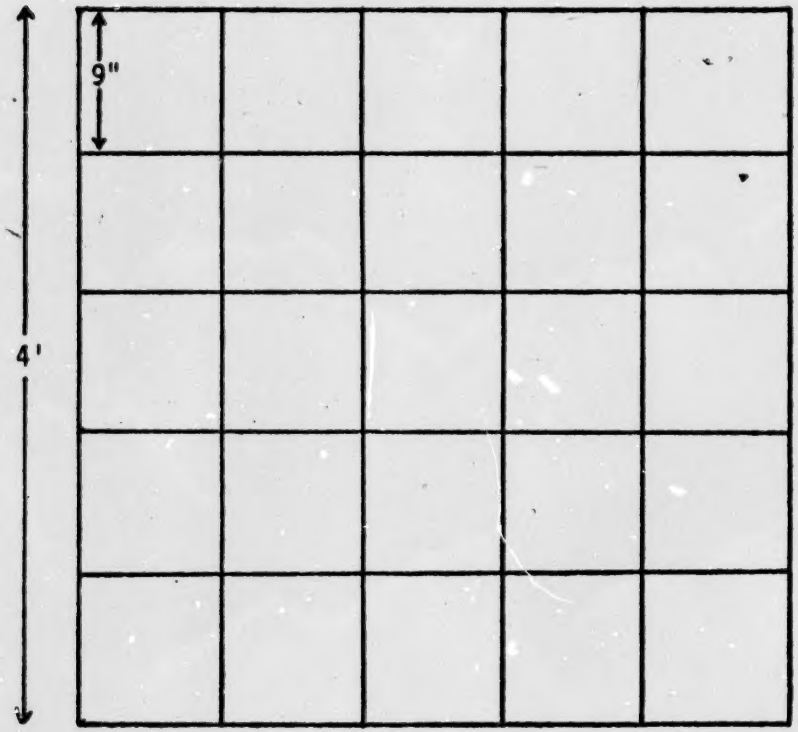
FIGURE 1 OPEN FIELD TEST FOR EMOTIONALITY



EMOTIONALITY MEASUREMENTS:

1. LATENCY---time (seconds) to leave the initial square.
2. TOTAL SQUARES---number of squares entered during the test period.
3. CENTRAL SQUARES---number of central squares entered during test period.
4. DEFECATION---number of boluses dropped during the test period.
5. URINATION---number of puddles during the test period.

EMOTIONALITY MEASUREMENTS

Group	Number of rats	Emergence time (sec)	Latency time (sec)	Total Squares	Central Squares	Defecation (boluses)	Urination (puddles)
Controls	33	*1947 ± 285	*94.1 ± 17.7	37.6 ± 6.3	1.26 ± .2	*1.80 ± .4	.44 ± .10
Runners	42	1173 ± 212	47.1 ± 9.2	*55.1 ± 6.8	1.78 ± .3	1.13 ± .3	.47 ± .06
Walkers	40	1482 ± 223	58.4 ± 13.2	42.2 ± 5.2	1.45 ± .3	1.50 ± .4	.50 ± .10
Swimmers	22	*2019 ± 300	42.8 ± 8.4	*52.5 ± 7.0	.71 ± .3	1.09 ± .4	.45 ± .09
Waders	29	1036 ± 262	54.2 ± 10.6	37.8 ± 5.5	.37 ± .3	.91 ± .3	.30 ± .30

Values are mean ± Standard Error

* Parameters which are significantly different from those of the other experimental groups ($P < .05$)